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(54) **APPARATUS FOR IMPROVED ANODE-CATHODE RATIO FOR RF CHAMBERS**

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USPC 204/298.11
See application file for complete search history.

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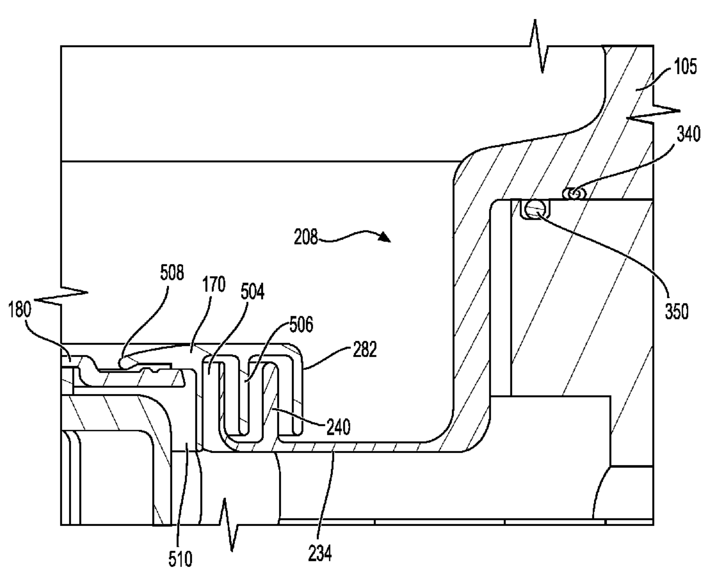
(57) **ABSTRACT**

Embodiments of process kits for use in plasma process chambers are provided herein. In some embodiments, a process kit for use in a process chamber includes an annular body having an upper portion and a lower portion extending downward and radially inward from the upper portion, wherein the annular body includes an inner surface having a first segment that extends downward, a second segment that extends radially outward from the first segment, a third segment that extends downward from the second segment, a fourth segment that extends radially outward from the third segment, a fifth segment that extends downward from the fourth segment, a sixth segment that extends radially inward from the fifth segment, a seventh segment that extends downward from the sixth segment, and an eighth segment that extends radially inward from the seventh segment.

17 Claims, 4 Drawing Sheets



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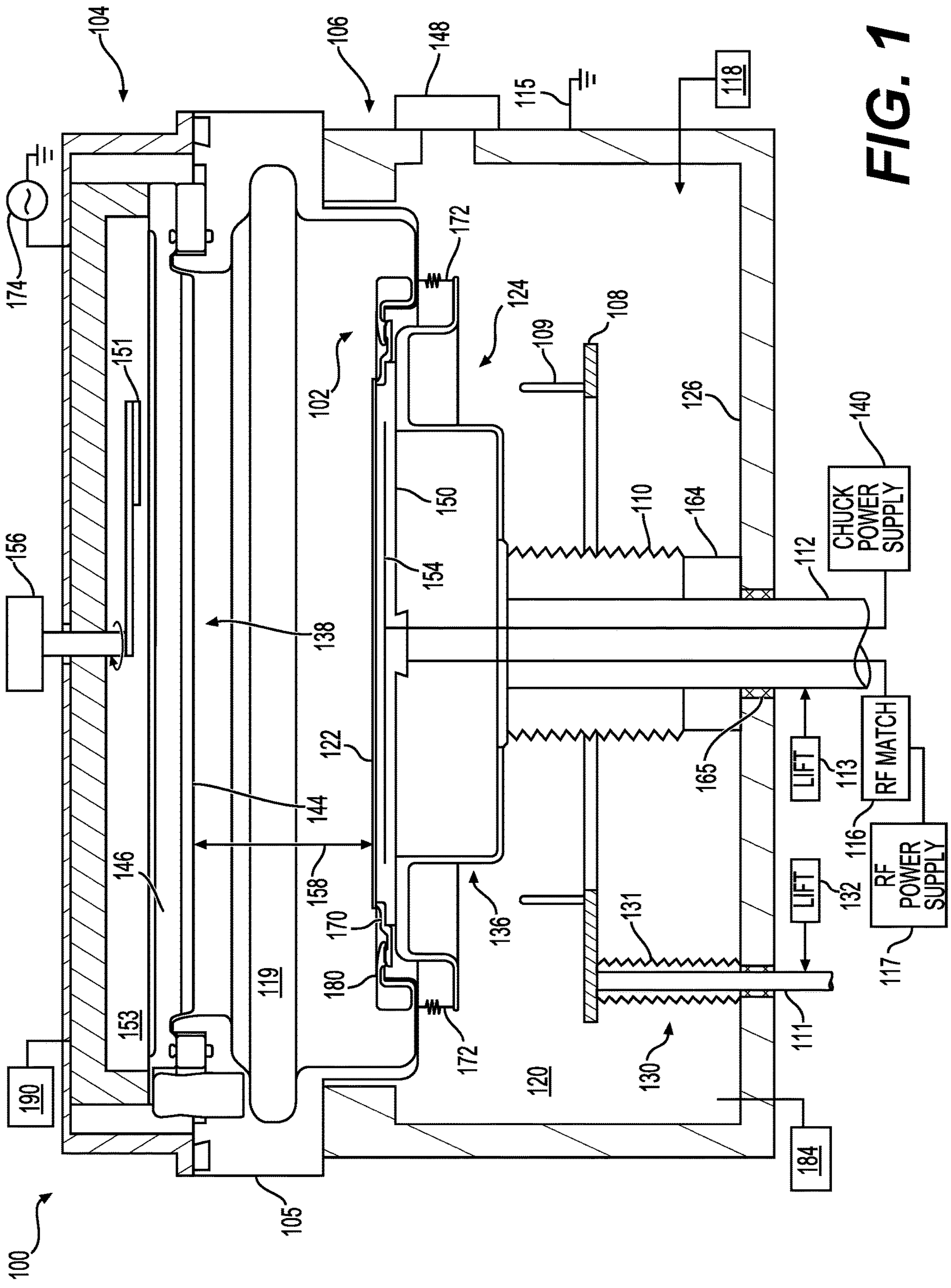
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104
105
106
148
115
118
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151
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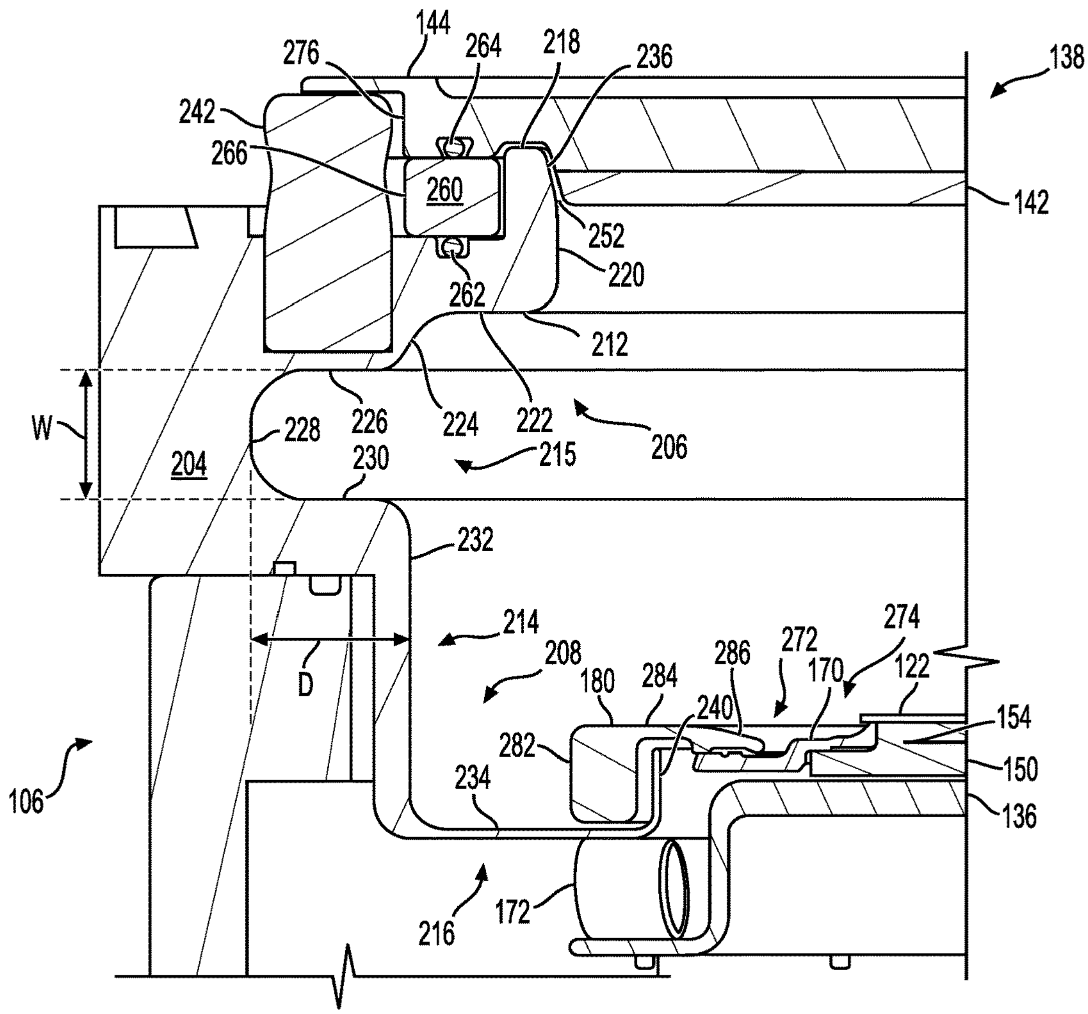
153
190
144
138
119
102
172
124
109
108
126
150
154
122
158
170
180
136
110
164
112
140
CHUCK POWER SUPPLY
165
LIFT
113
RF MATCH
116
RF POWER SUPPLY
117
LIFT
132
131
111
130
120
184

FIG. 1


144
264
218
236
138
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242
266
260
142
252
220
262
212
W
204
228
226
224
222
206
230
215
232
214
208
180
284
286
272
274
170
122
D
240
154
282
150
106
234
136
216
172

FIG. 2

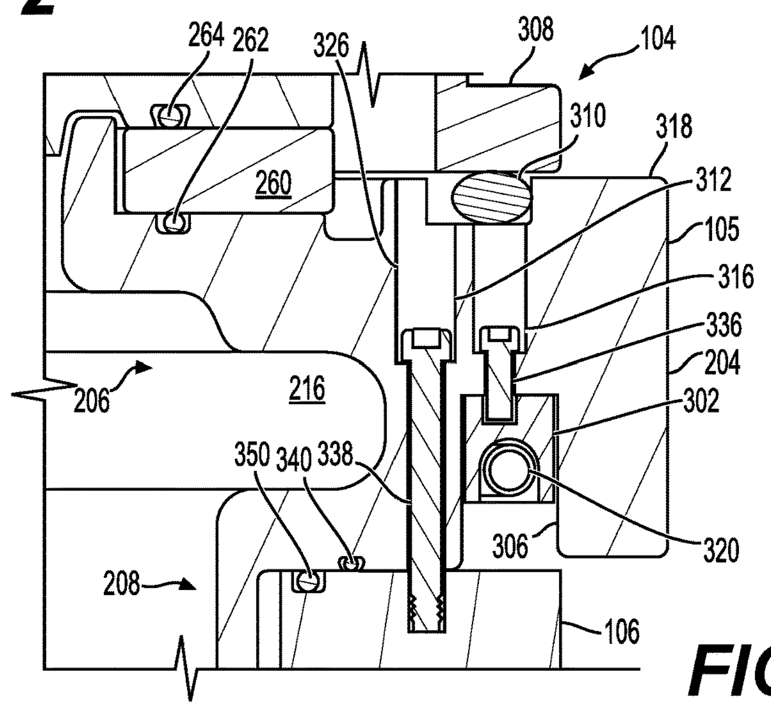
264
262
326
308
104
310
318
260
312
105
316
206
216
336
204
302
350
340
338
320
306
208
106

FIG. 3

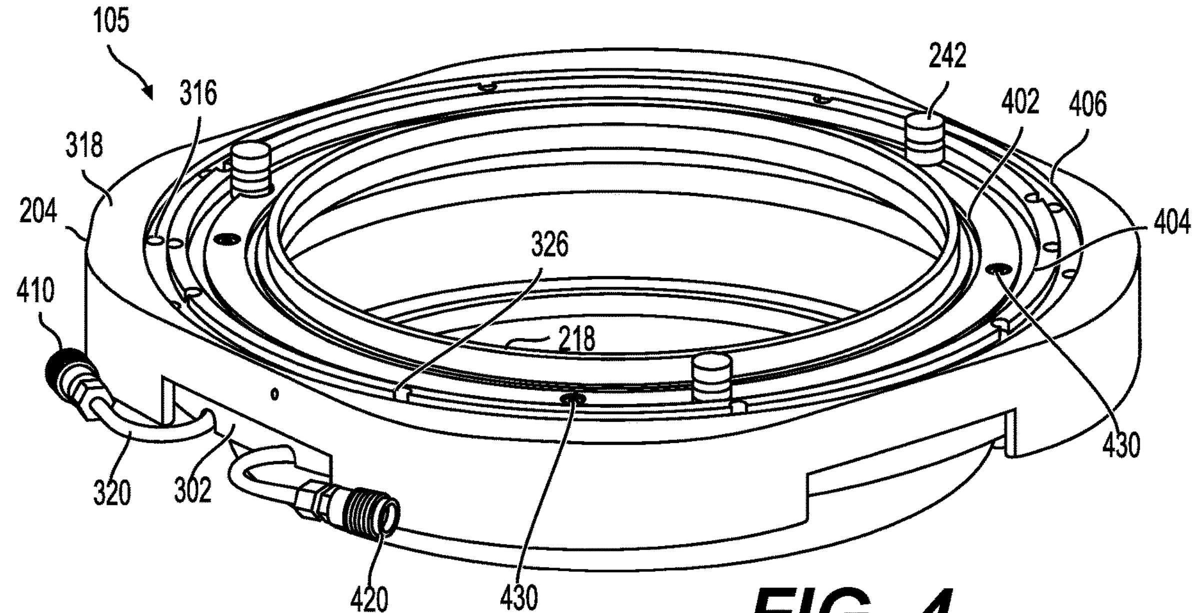
105
316
318
204
410
242
402
406
404
326
218
430
320
302
420
430

FIG. 4

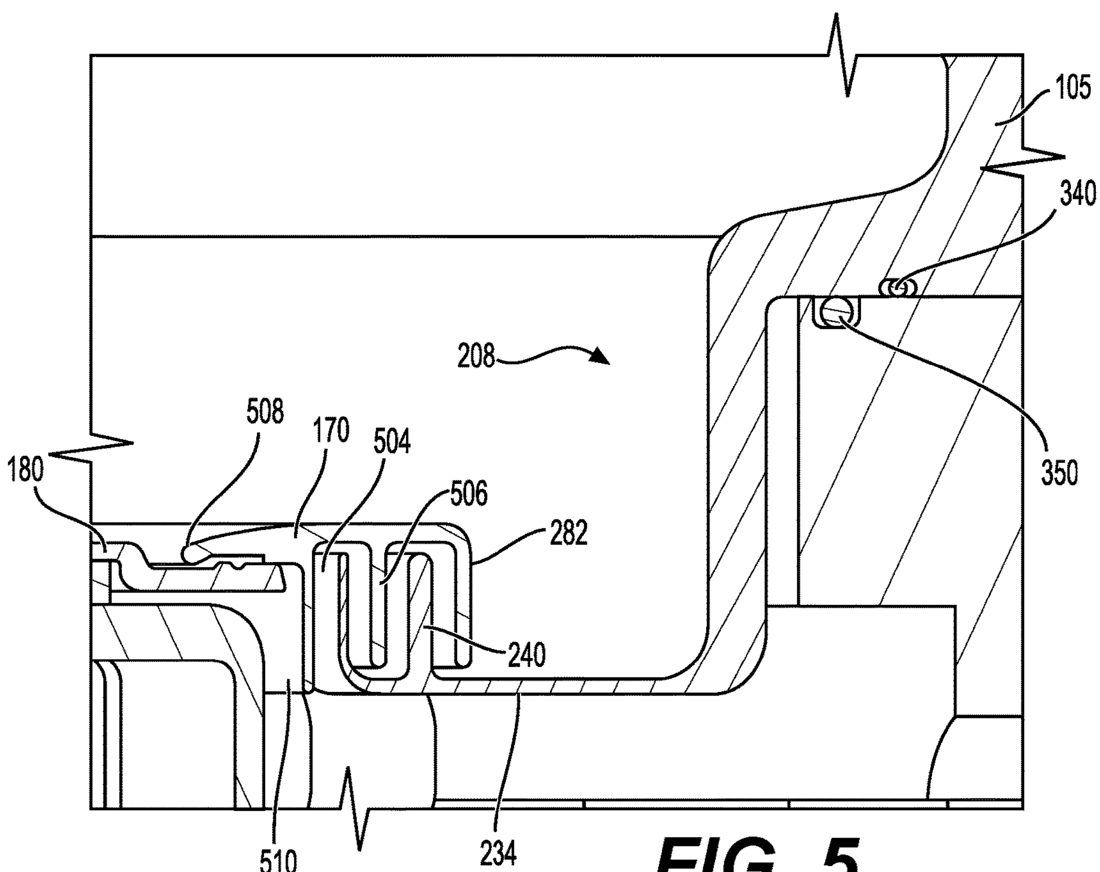
105
340
208
350
508
170
504
180
506
282
240
510
234

FIG. 5

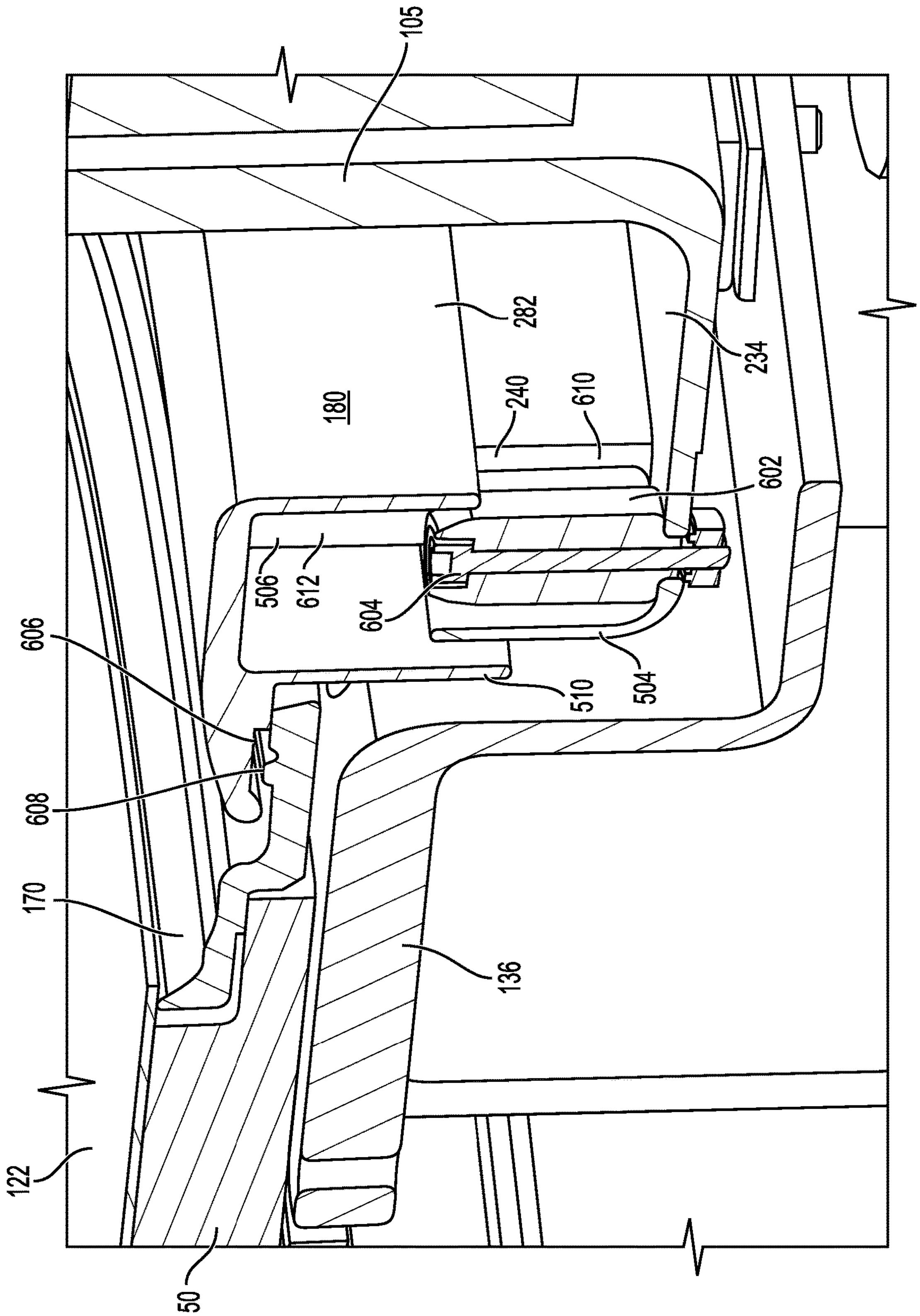
105
282
234
240
610
180
602
506
612
604
504
510
606
608
170
136
122
150

FIG. 6

APPARATUS FOR IMPROVED ANODE-CATHODE RATIO FOR RF CHAMBERS

FIELD

Embodiments of the present disclosure generally relate to substrate processing equipment.

BACKGROUND

Plasma process chambers typically include a substrate support to support a substrate and a target disposed opposite the substrate support. The target provides a source of material for sputtering onto the substrate during processing. RF power is provided to the plasma process chamber to create a plasma in a processing volume disposed between the target and the substrate support. Plasma process chambers typically include process kits for protecting chamber walls from unwanted deposition and to confine the plasma. Process kits generally include a process shield. For high RF power processes, a plasma facing surface of the process shield is prone to erosion, leading to unwanted particle generation of the material that makes up the process shield and unwanted re-sputtering of the target material disposed on the process shield. The inventors have observed that shorter spacing between the target and the substrate increases the contamination and re-sputtering issues.

Accordingly, the inventors have provided improved process kits.

SUMMARY

Embodiments of process kits for use in plasma process chambers are provided herein. In some embodiments, a process kit for use in a process chamber includes an annular body having an upper portion and a lower portion extending downward and radially inward from the upper portion, wherein the annular body includes an inner surface having a first segment that extends downward, a second segment that extends radially outward from the first segment, a third segment that extends downward from the second segment, a fourth segment that extends radially outward from the third segment, a fifth segment that extends downward from the fourth segment, a sixth segment that extends radially inward from the fifth segment, a seventh segment that extends downward from the sixth segment, and an eighth segment that extends radially inward from the seventh segment.

In some embodiments, a process kit for use in a process chamber, includes: a process shield having an upper portion and a lower portion having a first portion extending vertically downward from the upper portion, a second portion extending horizontally radially inward from the first portion, and a first inner lip extending upward from the second portion, wherein an inner surface of the upper portion includes an annular groove extending radially outward beyond the lower portion to increase a process volume facing surface of the process shield; and a coolant ring configured to flow a coolant therein coupled to the upper portion of the process shield.

In some embodiments, a process chamber, includes: a chamber body having an interior volume therein; a substrate support disposed in the interior volume; a target disposed in the interior volume opposite the substrate support to at least partially define a process volume therebetween, wherein the target includes a cathode surface defined by process volume facing surfaces of the target; and a process shield disposed about the substrate support and the target to define an outer boundary of the process volume, wherein the process shield includes an anode surface defined by process volume facing surfaces of the process shield, wherein a surface area of the anode surface is greater than two times a surface area of the cathode surface.

Other and further embodiments of the present disclosure are described below.

BRIEF DESCRIPTION OF THE DRAWINGS

Embodiments of the present disclosure, briefly summarized above and discussed in greater detail below, can be understood by reference to the illustrative embodiments of the disclosure depicted in the appended drawings. However, the appended drawings illustrate only typical embodiments of the disclosure and are therefore not to be considered limiting of scope, for the disclosure may admit to other equally effective embodiments.

FIG. **1** depicts a schematic side view of a process chamber having a process kit in accordance with at least some embodiments of the present disclosure.

FIG. **2** depicts a partial cross-sectional side view of a process chamber having a process kit in accordance with at least some embodiments of the present disclosure.

FIG. **3** depicts a partial cross-sectional side view of a process chamber having a process kit in accordance with at least some embodiments of the present disclosure.

FIG. **4** depicts an isometric top view of a process shield in accordance with at least some embodiments of the present disclosure.

FIG. **5** depicts a partial cross-sectional side view of a process chamber having a process kit in accordance with at least some embodiments of the present disclosure.

FIG. **6** depicts a partial cross-sectional view of a process chamber having the process kit of FIG. **5** in accordance with at least some embodiments of the present disclosure.

To facilitate understanding, identical reference numerals have been used, where possible, to designate identical elements that are common to the figures. The figures are not drawn to scale and may be simplified for clarity. Elements and features of one embodiment may be beneficially incorporated in other embodiments without further recitation.

DETAILED DESCRIPTION

Embodiments of process kits for use in plasma process chambers are provided herein. Process kits described herein include process shields. The inventors have observed that increasing the ratio of a plasma facing surface area of the process shield to a plasma facing surface area of a target disposed in the plasma process chamber (i.e., increasing the anode/cathode ratio) advantageously reduces contamination and re-sputtering issues. The novel process shield provides an anode/cathode ratio of about 2 or greater, for example, about 2 to about 3. In some embodiments, the process shield includes one or more annular grooves on an inner surface to increase a surface area of the anode. The process shield also extends below a substrate receiving surface of the substrate support to increase the surface area of the anode. The process shield may include a cooling ring coupled to the process shield to control a temperature of the process shield. The process kit may also include a cover ring that rests on the process shield when in a processing position and configured to define a tortuous path therebetween to reduce or prevent plasma leak through the process kit.

FIG. **1** depicts a schematic side view of a process chamber **100** (e.g., a plasma processing chamber) having a process kit in accordance with at least some embodiments of the present disclosure. In some embodiments, the process chamber **100** is an etch processing chamber. However, other types of processing chambers configured for different processes can also use or be modified for use with embodiments of the process kits described herein.

The process chamber **100** is a vacuum chamber which is suitably adapted to maintain sub-atmospheric pressures within an interior volume **120** during substrate processing. The process chamber **100** includes a chamber body **106** covered by a lid assembly **104** which encloses a processing volume **119** located in the upper half of the interior volume **120**. The chamber body **106** and lid assembly **104** may be made of metal, such as aluminum. The chamber body **106** may be grounded via a coupling to ground **115**.

A substrate support **124** is disposed within the interior volume **120** to support and retain a substrate **122**, such as a semiconductor wafer, for example, or other such substrate as may be electrostatically retained. The substrate support **124** may generally comprise an electrostatic chuck **150** disposed on a pedestal **136** and a hollow support shaft **112** for supporting the pedestal **136** and the electrostatic chuck **150**. The electrostatic chuck **150** comprises a dielectric plate having one or more electrodes **154** disposed therein. The pedestal **136** is generally made of a metal such as aluminum. The pedestal **136** is biasable and can be maintained at an electrically floating potential or grounded during plasma operation. The hollow support shaft **112** provides a conduit to provide, for example, backside gases, process gases, fluids, coolants, power, or the like, to the electrostatic chuck **150**.

In some embodiments, the hollow support shaft **112** is coupled to a lift mechanism **113**, such as an actuator or motor, which provides vertical movement of the electrostatic chuck **150** between an upper, processing position (as shown in FIG. **1**) and a lower, transfer position (not shown). A bellows assembly **110** is disposed about the hollow support shaft **112** and is coupled between the electrostatic chuck **150** and a bottom surface **126** of process chamber **100** to provide a flexible seal that allows vertical motion of the electrostatic chuck **150** while preventing loss of vacuum from within the process chamber **100**. The bellows assembly **110** also includes a lower bellows flange **164** in contact with an o-ring **165** or other suitable sealing element which contacts the bottom surface **126** to help prevent loss of chamber vacuum.

The hollow support shaft **112** provides a conduit for coupling a chuck power supply **140** and RF sources (e.g., RF power supply **174** and RF bias power supply **117**) to the electrostatic chuck **150**. In some embodiments, the RF power supply **174** and RF bias power supply **117** are coupled to the electrostatic chuck **150** via respective RF match networks (only RF match network **116** shown). In some embodiments, the substrate support **124** may alternatively include AC or DC bias power.

A substrate lift **130** can include lift pins **109** mounted on a platform **108** connected to a shaft **111** which is coupled to a second lift mechanism **132** for raising and lowering the substrate lift **130** so that the substrate **122** may be placed on or removed from the electrostatic chuck **150**. The platform **108** may be in the form of a hoop lift. The electrostatic chuck **150** may include through holes to receive the lift pins **109**. A bellows assembly **131** is coupled between the substrate lift **130** and bottom surface **126** to provide a flexible seal which maintains the chamber vacuum during vertical motion of the substrate lift **130**.

A target **138**, which acts as a cathode during processing, is disposed in the processing volume **119** opposite the substrate support **124** to at least partially define a process volume therebetween. The target **140** includes a cathode surface defined by processing volume facing surfaces of the target **138**. The substrate support **124** has a support surface having a plane substantially parallel to a sputtering surface of the target **138**. The target **138** is connected to one or both of a DC power source **190** and/or the RF power supply **174**. The DC power source **190** can apply a bias voltage to the target **138** relative to the process shield **105**.

The target **138** comprises a sputtering plate **142** mounted to a backing plate **144**. The sputtering plate **142** comprises a material to be sputtered onto the substrate **122**. The backing plate **144** is made from a metal, such as, for example, stainless steel, aluminum, copper-chromium or copper-zinc. The backing plate **144** can be made from a material having a thermal conductivity that is sufficiently high to dissipate the heat generated in the target **138**, which form from eddy currents that arise in the sputtering plate **142** and the backing plate **144** and also from the bombardment of energetic ions from generated plasma onto the sputtering plate **142**.

In some embodiments, the process chamber **100** includes a magnetic field generator **156** to shape a magnetic field about the target **138** to improve sputtering of the target **138**. The capacitively generated plasma may be enhanced by the magnetic field generator **156** in which, for example, a plurality of magnets **151** (e.g., permanent magnet or electromagnetic coils) may provide a magnetic field in the process chamber **100** that has a rotating magnetic field having a rotational axis that is perpendicular to the plane of the substrate **122**. The process chamber **100** may, in addition or alternatively, comprise a magnetic field generator **156** that generates a magnetic field near the target **138** to increase an ion density in the processing volume **119** to improve the sputtering of the target material. The plurality of magnets **151** may be disposed in a cavity **153** in the lid assembly **104**. A coolant such as water may be disposed in or circulated through the cavity **153** to cool the target **138**.

The process chamber **100** includes a process kit **102** circumscribing various chamber components to prevent unwanted reaction between such components and ionized process material. The process kit **102** includes a process shield **105** surrounding the substrate support **124** and the target **138** to at least partially define the processing volume **119**. For example, the process shield **105** may define an outer boundary of the processing volume **119**. The process shield **105** includes an anode surface defined by processing volume facing surfaces of the process shield **105**. In some embodiments, the process shield **105** is made of a metal such as aluminum.

In some embodiments, the process kit **102** includes a deposition ring **170** that rests on an outer edge of the electrostatic chuck **150**. In some embodiments, the process kit **102** includes a cover ring **180** disposed on the process shield **105** to form a tortuous gas flow path therebetween. In some embodiments, in the processing position, a radially inner portion of the cover ring **180** rests on the deposition ring **170** to reduce or prevent plasma leak therebetween.

In some embodiments, a distance between the target **138** and the substrate support **124** is about 60.0 mm to about 160.0 mm when the substrate support **124** is in a processing position. In some embodiments, a distance **158** between the target **138** and the substrate **122** when the substrate support **124** is in a processing position is about 90.0 mm to about 110.0 mm. The inventors have observed that the shorter spacing between the target **138** and the substrate **122** increases contamination and re-sputtering issues because of a shrinking anode surface area. Increasing the surface area of the anode without increasing the spacing between the target **138** and the substrate **122** advantageously provides the benefits of the shorter spacing between the target **138** and the substrate **122** while decreasing contamination and re-sputtering issues. In some embodiments, a surface area of the anode surface is advantageously greater than about two times a surface area of the cathode surface to reduce contamination and re-sputtering issues.

In some embodiments, a plurality of ground loops **172** are disposed between the process shield **105** and the pedestal **136**. The ground loops **172** may generally comprise a loop of conductive material, or alternatively, conductive straps, spring members, or the like, configured to ground the process shield **105** to the pedestal **136** when the substrate support **124** is in the processing position. In some embodiments, the plurality of ground loops **172** are coupled to an outer lip of the pedestal **138** so that in the processing position, the ground loops **172** contact the process shield **105** to ground the process shield **105**. In some embodiments, in the transfer position, the ground loops **172** are spaced from the process shield **105**.

The process chamber **100** is coupled to and in fluid communication with a vacuum system **19** which includes a throttle valve (not shown) and vacuum pump (not shown) which are used to exhaust the process chamber **100**. The pressure inside the process chamber **100** may be regulated by adjusting the throttle valve and/or vacuum pump. The process chamber **100** is also coupled to and in fluid communication with a process gas supply **118** which may supply one or more process gases to the process chamber **100** for processing the substrate **122** disposed therein. A slit valve **148** may be coupled to the chamber body **106** and aligned with an opening in a sidewall of the chamber body **106** to facilitate transferring the substrate **122** into and out of the chamber body **106**.

In use, while the DC power source **190** supplies power to the target **138** and other chamber components connected to the DC power source **190**, the RF power supply **174** energizes the sputtering gas (e.g., from the process gas supply **118**) to form a plasma of the sputtering gas. The plasma formed impinges upon and bombards the sputtering surface of the target **138** to sputter material off the target **138** onto the substrate **122**. In some embodiments, RF energy supplied by the RF power supply **174** may range in frequency from about 2 MHz to about 60 MHz, or, for example, non-limiting frequencies such as 2 MHz, 13.56 MHz, 27.12 MHz, or 60 MHz can be used. In some embodiments, a plurality of RF power sources may be provided (i.e., two or more) to provide RF energy in a plurality of the above frequencies. An additional RF power source, (e.g., RF bias power supply **117**) can also be used to supply a bias voltage to the substrate support **124** to attract ions form the plasma towards the substrate **122**.

FIG. **2** depicts a partial cross-sectional side view of a process chamber having a process kit in accordance with at least some embodiments of the present disclosure. In some embodiments, the process shield **105** includes an annular body **204** having an upper portion **206** and a lower portion **208** extending downward and radially inward from the upper portion **206**. In some embodiments, the lower portion **208** has a first portion **214** extending vertically downward from the upper portion **206** and a second portion **216** extending horizontally radially inward from the first portion **214**. An inner surface **212** of the annular body **204**, or anode surface corresponding with the processing volume facing surface of the annular body **204**, includes an annular groove **215** at the upper portion **206**. In some embodiments, the annular groove **215** extends radially outward beyond the lower portion **208** to increase a surface area of the inner surface **212**. In some embodiments, the annular groove **215** has a width W that is about 0.9 inches to about 3.0 inches. In some embodiments, the annular groove **215** has a width W that is about 0.8 inches to about 2.0 inches. In some embodiments, the width W is about is about 0.9 inches to about 1.1 inches. In some embodiments, the annular groove **215** has a depth D that is about 0.8 inches to about 2.0 inches. In some embodiments, the depth D is about 1.0 inches to about 1.5 inches.

In some embodiments, the inner surface **212** includes a first segment **220** that extends downward from an uppermost surface **218** of the annular body **204**. In some embodiments, the inner surface **212** includes a second segment **222** that extends radially outward from the first segment **220**. In some embodiments, the inner surface **212** includes a third segment **224** that extends downward from the second segment **222**. In some embodiments, the inner surface **212** includes a fourth segment **226** that extends radially outward from the third segment **224**. In some embodiments, the inner surface **212** includes a fifth segment **228** that extends downward from the fourth segment **226**. In some embodiments, the inner surface **212** includes a sixth segment **230** that extends radially inward from the fifth segment **228**. In some embodiments, the inner surface **212** includes a seventh segment **232** that extends downward from the sixth segment **230**. In some embodiments, the inner surface **212** includes an eighth segment **234** that extends radially inward from the seventh segment **232**. In some embodiments, the process shield **105** includes a first inner lip **240** extending upward from the eighth segment **234** or the second portion **216** of the lower portion **208**. In some embodiments, the inner surface **212** includes a ninth segment **236** that extends from the first segment **220** to the uppermost surface **218**. In some embodiments, the ninth segment **236** extends radially outward and upward.

A gap **252** is disposed between the target **138** and the process shield **105** to separate the anode from the cathode. For example, the gap **252** extends between the ninth segment **236** and the target **138** and between the target **138** and the uppermost surface **218** of the process shield **105**. In some embodiments, an isolator ring **260** is disposed between the target **138** and the process shield **105** to electrically isolate the target **138** from the process shield **105**. In some embodiments, a first o-ring **262** is disposed between an upper surface of the process shield **105** and a lower surface of the isolator ring **260**. In some embodiments, a second o-ring **264** is disposed between an upper surface of the isolator ring **260** and a lower surface of the target **138**.

In some embodiments, a plurality of ceramic plugs **242** are coupled to the upper portion **206** of the annular body **204** and configured to facilitate centering the target **238** to the annular body **204** to ensure that the gap **252** is substantially uniform. In some embodiments, the plurality of ceramic plugs **242** comprise three ceramic plugs arranged at regular intervals. In some embodiments, the plurality of ceramic plugs **242** extend beyond the uppermost surface **218** of the process shield **105**. In some embodiments, the isolator ring **260** includes a plurality of recesses **266** corresponding with locations of the plurality of ceramic plugs **242** to accommodate the plurality of ceramic plugs **242**. In some embodiments, the target **138** includes a plurality of recesses **276** corresponding with locations of the plurality of ceramic plugs **242** to accommodate the plurality of ceramic plugs **242**.

In some embodiments, the cover ring **180** has an annular body. In some embodiments, a first leg **282** of the cover ring **180** extends downward from a radially outer edge of the annular body. In some embodiments, the first leg **282** is disposed radially outward of the first inner lip **240** of the process shield to define a tortuous gas flow path therebetween. In some embodiments, the cover ring **180** includes an outer portion **284** having a substantially flat upper surface and an inner portion **286** having an upper surface that extends radially inward and downward. In some embodiments, a lower surface of the inner portion **286** is configured to rest on the deposition ring **170**. In some embodiments, the lower surface of the inner portion **286** includes a recessed portion **606** (see FIG. **6**) that does not rest on the deposition ring **170**.

In some embodiments, the deposition ring **170** rests on a peripheral notch of the electrostatic chuck **150**. In some embodiments, the deposition ring **170** includes an inner portion **274** that is raised with respect to an outer portion **272** of the deposition ring **170**. In some embodiments, the inner portion **286** of the cover ring **180** is configured to rest on the outer portion **272** of the deposition ring **170**. In some embodiments, an upper surface of the outer portion **272** of the deposition ring **170** has a protrusion **608** (see FIG. **6**) that extends into the recessed portion **606** of the cover ring **180** to create a tortuous path for any plasma that may leak between the cover ring **180** and the deposition ring **170**.

FIG. **3** depicts a partial cross-sectional side view of a process chamber having a process kit in accordance with at least some embodiments of the present disclosure. In some embodiments, a coolant ring **302** is coupled to the upper portion **206** of the annular body **204** to cool the annular body **204**. In some embodiments, the coolant ring **302** includes a coolant tube **320** disposed or embedded therein and configured to circulate a coolant therethrough. In some embodiments, the coolant ring **302** is disposed in an annular channel **306** extending from a lower surface **304** of the upper portion **206**. In some embodiments, the upper portion **206** includes holes **316** extending from a top surface **318** for mounting the annular body **204** to the coolant ring **302** (e.g. via fasteners **336**). In some embodiments, the holes **316** comprise 8 or more holes, for example, 16 holes.

In some embodiments, the upper portion **206** includes holes **326** extending from the top surface **318** for mounting the annular body **204** to the chamber body **106** (e.g., via fasteners **338**). In some embodiments, the holes **326** comprise 4 or more holes, for example 8 holes. In some embodiments, the upper portion **206** has a wall **312** disposed between the holes **316** and the holes **326**. In some embodiments, one or more locating features may be disposed between the chamber body **106** and the upper portion **206** to align the process shield **105** to the chamber body **106**. For example, one or more locating pins may be coupled to the upper portion **206** and extend beyond the lower surface **304** of the upper portion **206** and into a corresponding opening in the chamber body to align the process shield **105** to the chamber body **106**.

In some embodiments, a conductive spring member **310**, for example an RF gasket, may be disposed between the upper portion **206** and an outer housing **308** of the lid assembly **104** to ground the outer housing **308**. In some embodiments, a third o-ring **340** is disposed between the lower portion **208** and the chamber body **106** to provide a seal therebetween. In some embodiments, a fourth o-ring

350 is disposed between the lower portion **208** and the chamber body **106** to provide a seal therebetween.

FIG. **4** depicts an isometric top view of a process shield in accordance with at least some embodiments of the present disclosure. The coolant tube **320** includes an inlet **410** and an outlet **420** for circulating a coolant therethrough. In some embodiments, the top surface **318** of the annular body **204** includes a first annular groove **402** to accommodate the second o-ring **264**. In some embodiments, the top surface **318** of the annular body **204** includes a second annular groove **406** to accommodate the conductive spring member **310**. In some embodiments, the holes **316** extend from the second annular groove **406** to the annular channel **306**. In some embodiments, the holes **326** extend at least partially from the second annular groove **406** to the lower surface **304** of the upper portion **206** of the process shield **105**.

In some embodiments, the top surface **318** of the annular body **204** includes an annular trap groove **404** configured to collect any coolant that leaks onto the annular body **204** from the cavity **153** in the lid assembly **104**. In some embodiments, the annular trap groove **404** is disposed radially between the first annular groove **402** and the second annular groove **406**. In some embodiments, the plurality of ceramic plugs **242** are partially disposed in the annular trap groove **404**. In some embodiments, the annular trap groove **404** has a width of about 0.35 inches to about 0.50 inches. In some embodiments, there is a gap of about 0.05 inches to about 0.10 inches between an outer sidewall of the annular trap groove **404** and each one of the plurality of ceramic plugs **242**. In some embodiments, the annular trap groove **404** comprises a plurality of trap groove arc segments that terminate proximate the plurality of ceramic plugs **242**. In such embodiments, the plurality of ceramic plugs **242** are not disposed in the annular trap groove **404**. In some embodiments, the top surface **318** includes a plurality of lifting holes **430** to facilitate installation and removal of the process shield **105**.

FIG. **5** depicts a partial cross-sectional side view of a process chamber having a process kit in accordance with at least some embodiments of the present disclosure. In some embodiments, the lower portion **208** of the process shield **105** includes a second inner lip **504** extending upward from the eighth segment **234** radially inward from the first inner lip **240**. In some embodiments, the second inner lip **504** extends substantially parallel to the first inner lip **240**. In some embodiments, the cover ring **180** includes a second leg **506** that extends downward from the annular body of the cover ring **180** at a location between the first leg **282** and a radially inner surface **508** of the annular body. The second leg **506** extends between the first inner lip **240** and the second inner lip **504** when the cover ring **180** is disposed on the process shield **105**. In some embodiments, the cover ring **180** includes a third leg **510** that extends downward from the annular body of the cover ring **180** and disposed radially inward from the second leg **506**. The second inner lip **504** and the second leg **506** advantageously provide enhanced plasma confinement.

FIG. **6** depicts a partial cross-sectional view of a process chamber having the process kit of FIG. **5** in accordance with at least some embodiments of the present disclosure. In some embodiments, one or more centering bushings **602** are disposed between first leg **282** of the cover ring **180** and the second inner lip **504** of the process shield **105** configured to center the cover ring **180** to the process shield **105** when in the processing position. In some embodiments, the first inner lip **240** includes one or more cutouts **610** to accommodate the one or more centering bushings **602**. In some embodiments, the second leg **506** of the cover ring **180** includes one or more cutouts **612** to accommodate the one or more centering bushings **602**. In some embodiments, the one or more centering bushings **602** are coupled to the process shield **105** via corresponding one or more fasteners **604**. In some embodiments, the one or more centering bushings **602** are three centering bushings.

While the foregoing is directed to embodiments of the present disclosure, other and further embodiments of the disclosure may be devised without departing from the basic scope thereof.

The invention claimed is:

1. A process kit for use in a process chamber, comprising:

an annular body having an upper portion and a lower portion extending downward and radially inward from the upper portion, wherein the annular body includes an inner surface having a first segment that extends downward, a second segment that extends radially outward from the first segment, a third segment that extends downward from the second segment, a fourth segment that extends radially outward from the third segment, a fifth segment that extends downward from the fourth segment, a sixth segment that extends radially inward from the fifth segment, a seventh segment that extends downward from the sixth segment, and an eighth segment that extends radially inward from the seventh segment, wherein a top of the annular body includes an annular trap groove configured to collect any coolant that leaks onto the annular body.

2. The process kit of claim **1**, further comprising a first inner lip extending upward from the eighth segment.

3. The process kit of claim **2**, further comprising a second inner lip extending upward from the eighth segment radially inward from the first inner lip.

4. The process kit of claim **1**, further comprising a coolant ring coupled to the upper portion of the annular body.

5. The process kit of claim **1**, further comprising a plurality of ceramic plugs coupled to an upper surface of the annular body configured to facilitate centering the annular body to a target of the process chamber.

6. The process kit of claim **1**, wherein the upper portion includes holes for mounting the annular body to chamber walls of the process chamber.

7. The process kit of claim **1**, wherein a top surface of the annular body includes a first annular groove and a second annular groove.

8. The process kit of claim **1**, wherein the inner surface includes a ninth segment that extends radially outward and upward from the first segment.

9. A process kit for use in a process chamber, comprising:

a process shield having an upper portion and a lower portion having a first portion extending vertically downward from the upper portion, a second portion extending horizontally radially inward from the first portion, a first inner lip extending upward from the second portion, a second inner lip substantially parallel to the first inner lip and radially inward of the first inner lip, wherein an inner surface of the upper portion includes an annular groove extending radially outward beyond the lower portion to increase a surface area of the inner surface;

a coolant ring configured to flow a coolant therein coupled to the upper portion of the process shield; and

a cover ring having an annular body, wherein a first leg of the cover ring extends downward from a radially outer edge of the annular body, wherein the first leg is disposed radially outward of the first inner lip of the process shield to define a tortuous gas flow path therebetween, wherein a second leg of the cover ring extends downward from the annular body at a location between the first leg and a radially inner surface of the annular body, wherein the second leg extends between the first inner lip and the second inner lip when the cover ring is disposed on the process shield.

10. The process kit of claim **9**, wherein the annular groove is about 0.8 inches to about 2.0 inches wide and about 0.8 inches to about 2.0 inches deep.

11. The process kit of claim **9**, further comprising one or more centering bushings disposed between first leg of the cover ring and the second inner lip of the process shield when the cover ring is disposed on the process shield to center the cover ring to the process shield.

12. A process chamber, comprising:

a chamber body having an interior volume therein;

a substrate support disposed in the interior volume;

a target disposed in the interior volume opposite the substrate support to at least partially define a process volume therebetween, wherein the target includes a cathode surface defined by process volume facing surfaces of the target; and

a process shield disposed about the substrate support and the target to define an outer boundary of the process volume, wherein the process shield includes an anode surface defined by process volume facing surfaces of the process shield, wherein a surface area of the anode surface is greater than two times a surface area of the cathode surface, and wherein the process kit as described in claim **1** forms the process shield.

13. The process chamber of claim **12**, wherein a distance between the target and the substrate support is about 60.0 mm to about 160.0 mm in a processing position.

14. The process chamber of claim **12**, further comprising a plurality of ceramic plugs coupled to a top surface of the process shield to align the process shield with the target.

15. The process chamber of claim **12**, wherein the process shield includes a coolant ring configured to flow a coolant therethrough.

16. The process chamber of claim **12**, further comprising a plurality of ground loops coupled to the substrate support and configured to contact the process shield to ground the process shield when the substrate support is in a processing position.

17. A process kit for use in a process chamber, comprising:

an annular body having an upper portion and a lower portion extending downward and radially inward from the upper portion, wherein the annular body includes an inner surface having a first segment that extends downward, a second segment that extends radially outward from the first segment, a third segment that extends downward from the second segment, a fourth segment that extends radially outward from the third segment, a fifth segment that extends downward from the fourth segment, a sixth segment that extends radially inward from the fifth segment, a seventh segment that extends downward from the sixth segment, an eighth segment that extends radially inward from the seventh segment, a first inner lip extending upward from the eighth segment, and a second inner lip extending upward from the eighth segment radially inward from the first inner lip.

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